JACC: CARDIOVASCULAR IMAGING VOL. 4, NO. 3, 2011

ISSN 1936-878X/$36.00
PUBLISHED BY ELSEVIER INC. DOI:10.1016/j.jcmg.2011.01.003

EDITORIAL COMMENT

Diastolic Dysfunction and Computed Tomography*

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Left ventricular (LV) diastolic dysfunction is being increasingly recognized as a marker of risk both in ischemic and nonischemic cardiomyopathies. In fact, the syndrome of congestive heart failure, classically considered a hallmark of systolic dysfunction, can be completely dependent on diastolic dysfunction of the LV (1), and its long-term prognosis is similarly poor. In the natural history of coronary artery disease, abnormalities in diastolic filling may precede measurable abnormalities in systolic function (2–3), and similar concepts operate in other disease states such as early transplant rejection.

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The presence of abnormalities of LV diastolic function is therefore of interest to the practicing cardiologist. The word diastole derives from a Greek term that means "the act of dilating or expanding." This action is composed of 2 phases in the LV cycle: an early filling phase, which is dependent upon active relaxation of the LV causing a suctioning effect on the transmitral blood flow, and a late phase influenced by the compliance characteristics of the myocardium. The classic, and likely most sensitive, way to assess LV diastolic function is to measure the change in intracavitary pressure for a given change in blood volume by means of conductance catheters. However, several noninvasive methods have been developed to assess this important LV parameter. Although accurate measurements of diastolic function can be obtained with radionuclide angiography and cardiac magnetic resonance, echocardiography is the most readily accessible tool for the majority of practicing cardiologists. Several echocardiographic methods are currently in use; some are volume dependent, such as transmitral and pulmonary vein blood flow velocities, whereas others are volume independent, such as color flow propagation in the LV cavity and Doppler tissue imaging. Although only indirect evidence of increased left atrial pressure, the left atrial size and volume are also easily measured with echocardiography and provide prognostic information as to the development of atrial fibrillation, stroke, congestive heart failure, and risk of death (4). In this issue of *iJACC*, Boogers et al. (5) report on their experience with a recent-generation multidetector computed tomography (MDCT) scanner to assess LV diastolic function compared with Doppler techniques. They conclude that MDCT imaging showed close to 80% accuracy in comparison with Doppler. Assessment of LV diastolic function with computed tomography (CT) is not entirely novel. When cardiac CT was first attempted with the "dynamic spatial reconstructor," the equipment was extremely large and the time required for processing a set of images was very long; however, the measurements of mass and volume (and therefore function) were rather accurate (6,7) The "dynamic spatial reconstructor" never became commercially available because of the appearance on the market of the electron beam CT scanner with more favorable imaging characteristics and computer power (8). In view of its high temporal resolution and acceptable, albeit modest, spatial resolution, the electron beam CT scanner quickly proved to be an accurate tool for the measurement of LV mass, volume, and function. Diastolic LV function was calculated by fitting a third-order polynomial to the time-volume curve to find the inflection point during diastole (peak filling rate). This technique gave results that were remarkably similar to those of radionuclide angiography used as a gold standard (9).

In their article, Boogers et al. (5) performed a series of clever mathematic analyses to derive parameters of diastolic function from multiphase MDCT images that would be comparable to Doppler-derived measures of diastolic function. The analyses were conducted retrospectively on 70 patients referred for assessment of

*Editorials published in *JACC: Cardiovascular Imaging* reflect the views of the authors and do not necessarily represent the views of *JACC: Cardiovascular Imaging* or the American College of Cardiology.

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Dr. Raggi has received a research grant from General Electric.

coronary artery disease; all patients had normal LV function, were in normal sinus rhythm at the time of CT imaging, and had no significant valvulopathy. Nitroglycerin was not used before CT imaging, as is routinely done to image the coronary arteries in most laboratories, but the authors provide no further detail as to why they did not. The acquisition was dynamic (performed throughout the cardiac cycle), with retrospective gating that allowed for analysis of multiple phases in the cardiac cycle. The CT assessment of diastolic LV function was based on calculations of transmitral flow velocity (using a series of volume changes over time, as well as the mitral valve area) and mitral ring motion velocity measured at the septum (using a series of distance measurements between the mitral valve ring and the apex of the LV). The entire process required approximately 20 min of work, and the interreader and intrareader variability was very small. The correlation between CT and echocardiographic measurements of peak mitral in-flow velocity (E), E/A ratio, and the E/Ea (peak mitral ring velocity) ratio was good albeit not excellent (r = 0.73 to 0.87). The overall accuracy of CT for the detection of diastolic dysfunction, defined as the agreement of CT findings with a set of pre-established echocardiographic criteria, was 79%. The authors therefore showed the potential utility of MDCT in defining another important parameter of risk for patients being investigated for the presence of coronary artery disease.

Several limitations, however, need to be addressed. Maybe the most egregious of all was the use of retrospective gating without the use of dose modulation in all patients; this approach provided the information necessary for performance of the study (all phases in the cardiac cycle) and the best possible image quality. However, these 2 techniques have been modified to reduce the large radiation dose provided to the patient under investigation; currently, prospective gating or retrospective gating with dose modulation are widely used, especially for patients with low pre-test probability of disease. The authors did not use sublingual nitroglycerin (which may transiently modify the diastolic characteristics of the LV) before coronary CT angiography, and this is also a deviation from the protocols used in most laboratories. Finally, all patients had normal LV systolic function, and one wonders what correlation CT and echocardiography would hold in the presence of LV systolic dysfunction in which diastolic abnormalities are most often present. Indeed, Doppler markers of diastolic function are most accurate in the presence of abnormal LV systolic function (10); therefore, the correlation between CT and echocardiography remains to be tested in this setting. Although the measurement of LV diastolic parameters on CT was relatively short (approximately 20 min), it was considerably longer than the rapid interpretation of Doppler parameters typically performed during echocardiographic investigations. Despite these limitations, the paper by Boogers et al. (5) provides an insight into a novel approach to assess LV diastolic function in the same setting in which systolic function of the LV and coronary artery disease anatomy are defined; this makes modern MDCT technology move another step toward the achievement of a comprehensive evaluation of cardiovascular structure and function.

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Key Words: cardiac computed tomography ▪ left ventricle diastolic function ▪ left ventricle volume.